Palestine Polytechnic University
Mechanical Engineering Department
Theory of Machine
first

Instructor: En. Jalal Salaimeh
Date: 05/11/2012
Time: 60 min.

Student Name:
Student Number:
Section: 1

www.vGloop.com/group.php?id=54

Notes: 1) Solve problems P1, P2,P3 each on its page.
2) Write your name on each page.

Question #	1(6)	2(6)	3(8)	Total Grade (20)
Grade	4	2.5	8	14.5

P1) (6 points)

For the mechanism in Fig. P1 :
a) Describe the motion for each link.
b) Determine the mobility of the mechanism.

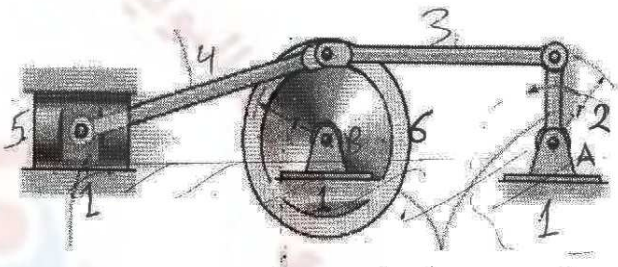


Fig. P1

a)

link 1: Frame (fixed)

link 2: Rotating about pin A

link 3: General plane motion

link 4: General plane motion

link 5: Translation (sliding)

link 6: Rotating about pin B

www.vGloop.com/group.php?id=54

b) $n = 6$

j_1: 5 pin + 1 sliding

$j_1 = 6$

$j_2 = 0$

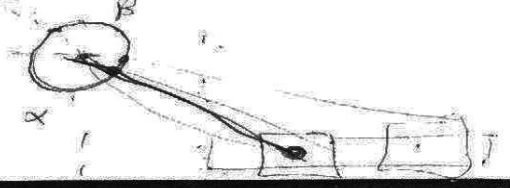
$$M(dof) = 3(n-1) - 2j_1 - j_2$$

$$M = 3 \times 5 - 2 \times 6 - 0$$

$$M = 15 - 12 = 3$$

$$\boxed{M = 3}$$

Student Name:
Student Number:



P2) (6 points)

Fig. P2 shows the lay out of a quick return mechanism of the oscillating link type, for a special purpose machine. The driving crank BC is 120 mm long , the distance centers AC is 240 mm. and the distance AP is 450mm.
Determine:

a) The quick return ratio for this mechanisms.
b) the length of the working stroke of R.

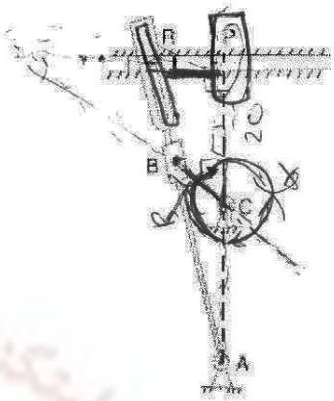
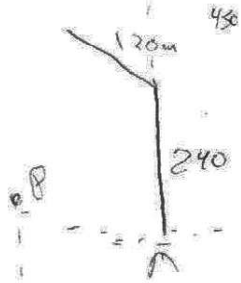
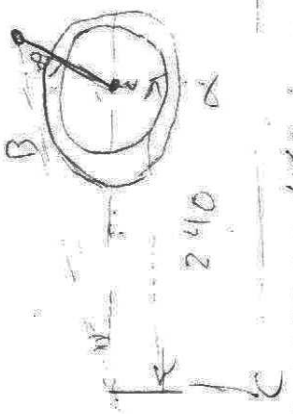
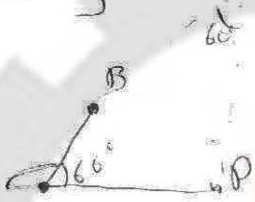


Fig. P2





from the Geomedry



$\beta = 180 - 60 = 120^\circ$ How?

$\alpha = 360 - \beta = 360 - 120$

$\alpha = 240^\circ$

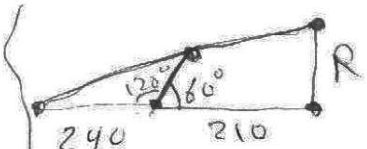
a) Time ratio = $\frac{\text{Time of reluce sforke}}{\text{Time of return sforke}}$

Time ratio = $\frac{\frac{\alpha}{w}}{\frac{\beta}{w}} = \frac{\alpha}{\beta} = 2$

b) $\tan 60 = \frac{R}{210}$

$R = 210 \tan 60$

$R = 363.73\ mm$



www.vGloop.com/group.php?id=54

Student Name:
Student Number:

P3) (8 points)

At the instant $\theta = 45°$, link DC in Fig. P3 has an angular velocity of $\omega_{DC} = 4$ rad/s and an angular acceleration of $\alpha_{DC} = 2$ rad/s^2. Determine the angular velocity and angular acceleration of rod AB at this instant. The collar at C is pin connected to DC and slides freely along AB.

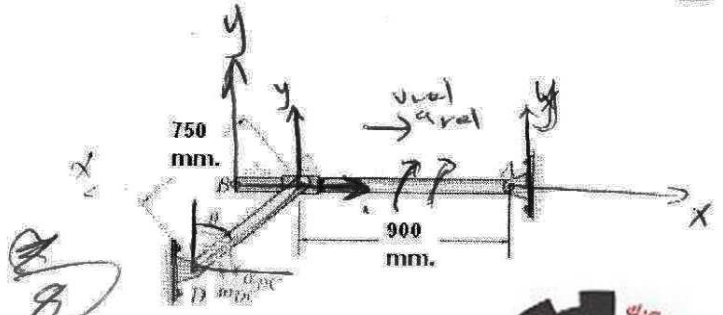


Fig. P3

$V_A = 0$

$\alpha_{AB} = -\alpha_{AB}\,\hat{k}$

$\omega_{AB} = -\omega_{AB}\,\hat{k}$

$r = 0.9\,i$

$V_{rel} = V_{AB}\,i$

$a_{rel} = a_{AB}\,i$

$V_D = 0 \quad \omega_{DC} = 4$ rad/s $= -4k$

$\alpha_{DC} = 2$ rad/s$^2 = -2k$

for rod DC:

$r = 750\cos 45°\,j + 750\sin 45°\,i \Rightarrow \vec{r} = \frac{750}{1000}\sin 45°\,i + \frac{750}{1000}\cos 45°\,j$

$r = 0.75\sin 45\,i + 0.75\cos 45\,j$

$V_c = V_D + V_{c/D} + V_{rel}$

$V_c = \omega_{DC} \times r = 4k \times \left(\frac{750}{1000}\sin 45\,i + \frac{750}{1000}\cos 45°\,j\right)$

$V_c = -3\cos 45\,i + 3\sin 45\,j$ m/s

$a_c = a_D + \alpha \times r + (-\omega^2 r)$

$a_c = 2k \times (0.75\sin 45\,i + 0.75\cos 45\,j) - (4)^2 \cdot [0.75\sin 45\,i + 0.75\cos 45\,j]$

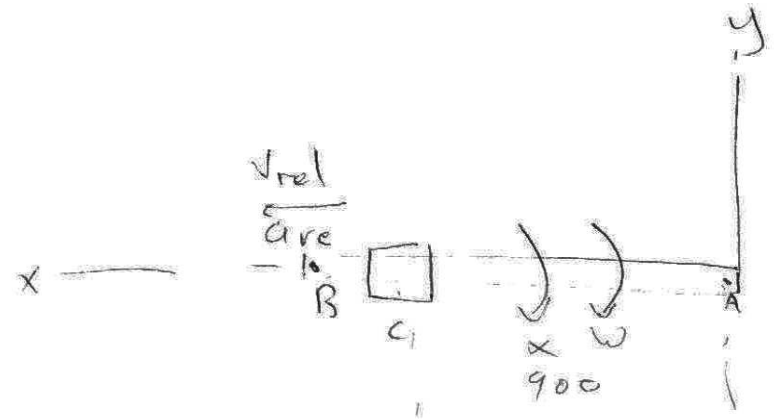
$a_c = -1.5\cos 45\,i + 1.5\sin 45\,j + [12\sin 45\,i + 12\cos 45\,j]$

$\cos 45 = \sin 45$

$a_c = [-13.5\sin 45\,i + 13.5\cos 45\,j]$

www.vGloop.com/group.php?id=5

Q3



www.vGloop.com/group.php?id=54

$V_A = 0$

$\alpha_{AB} = \alpha_{AB}\, k$

$\omega_{AB} = \omega_{AB}\, k$

$r = 0.9\, i$

$V_{rel} = V_{AB}\, i$

$a_{rel} = a_{AB}\, i$

$$V_C = V_A + \omega \times r + V_{AB}\, i$$

$$-3\cos 45\, i + 3\sin 45\, j = \omega k \times (0.9\, i) + V_{AB}\, i$$

$$-3\cos 45\, i + 3\sin 45\, j = 0.9\omega\, j + V_{AB}\, i$$

$0.9\omega = 3\sin 45 \Rightarrow \boxed{\omega_{AB} = 2.36 \text{ rad/s}}$

$V_{AB} = -3\cos 45 \Rightarrow \boxed{V_{AB} = 2.12 \text{ m/s} \rightarrow \text{(to the right)}}$

$$a_C = a_A + \alpha \times r + \omega \times (\omega \times r) + 2\omega \times V_{rel} + a_{rel}$$

$$-13.5\sin 45\, i + 13.5\cos 45\, j = \alpha k \times (0.9\, i) + \omega k \times (\omega k \times 0.9\, i) + 2\omega k \times (-2.12\, i) + a_{rel}\, i$$

$$-13.5\sin 45\, i + 13.5\cos 45\, j = 0.9\alpha\, j + (-0.9\omega^2)\, i + (-4.24\omega)\, j + a_{rel}\, i$$

$$= 0.9\alpha\, j - 5.012\, i - 10\, j + a_{rel}\, i$$

$$-13.5\sin 45\, i + 13.5\cos 45\, j = (0.9\alpha - 10)\, j + (a_{rel} - 5)\, i$$

$-13.5\sin 45 = a_{rel} - 5 \Rightarrow a_{rel} = -4.5 \text{ m/s} \rightarrow \text{(to the right)}$

$13.5\cos 45 = 0.9\alpha - 10 \Rightarrow \boxed{\alpha_{AB} = 21.72 \text{ rad/s}^2}$